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PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

AN ACQUISITION MANAGEMENT GUIDE TO
PRODUCT ASSURANCE AND TEST FOR
ARMY PROGRAM MANAGERS

STUDY PROJECT REPORT
PMC 77-2

Maxwell E. Westmoreland
GS-14 DAC

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE: AN ACQUISITION MANAGEMENT GUIDE TO PRODUCT ASSURANCE AND TEST FOR ARMY PROGRAM MANAGERS

STUDY PROJECT GOALS:

To develop a management guide for Army program managers which will describe the product assurance and test work breakdown structure and show how this structure interfaces with the overall acquisition process.

STUDY REPORT ABSTRACT:

The purpose of this report is to develop a basis for understanding, from a management viewpoint, the process of accomplishing product assurance and test functions during Army acquisition programs. To achieve this purpose, a management guide for Army project managers is developed. This guide describes the product assurance and test work breakdown structure and shows how this structure interfaces with the overall acquisition process.

The guide is intended to be used by project managers to obtain an overall perspective of the management aspects of the product assurance and test functions. It emphasizes what a manager needs to know and do about product assurance and test as he utilizes this functional tool to help him achieve his program goals.

SUBJECT DESCRIPTORS:

Test and Evaluation (10.08)

Organizational Structure (10.03.01)

Systems Engineering Management (10.05.01, .02, ard .08)

Quality Assurance (10.09.11)

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November 1977

AN ACQUISITION MANAGEMENT GUIDE TO PRODUCT ASSURANCE AND TEST FOR ARMY PROGRAM MANAGERS

Individual Study Program

Study Project Report

Prepared as a Formal Report

Defense Systems Management College

Program Management Course

Class 77-2

by

Maxwell E. Westmoreland
GS-14 DAC

November 1977

Study Project Advisor
Mr. Wayne J. Schmidt

EXECUTIVE SUMMARY

This report develops a basis for understanding, from a management viewpoint, the process of accomplishing product assurance and test functions during Army acquisition programs. To achieve this purpose, a management guide for Army project managers is developed. The guide emphasizes what a manager needs to know and do about product assurance and test as he utilizes this functional tool to help him achieve his program goals. Topics included are what is product assurance and test, how the function fits into the acquisition process, what work has to be done, how the work gets done, and management considerations for planning and control.

ACKNOWLEDGEMENTS

Many of the ideas presented in this paper have been developed in over eight years of professional association with Mr. Seymour J. Lorber, Director of Quality Assurance, and Mr. Arthur H. Nordstrom, Jr., Chief, Reliability and System Assessment Division, US Army Materiel Development and Readiness Command. I am forever indebted to them for their guidance and opportunities they provided for my professional development. I am especially grateful to Ms. Shirley W. Pannell for the excellent job she did in typing the manuscript.

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SECTION I

INTRODUCTION

The Project Manager's Challenge

In today's materiel acquisition environment, the project manager's[1] challenge is to achieve his program requirements under highly structured constraints. The requirements are usually set in the areas of cost, schedule, and technical performance. The constraints usually involve staffing, dollars, time, organization, authority limits, and technical risks. In this environment, the project manager's task is to integrate the diverse program elements toward achievement of the program goals while striking a program balance by a process of trade-offs among cost, schedule, and technical performance requirements within the various constraint levels. This dynamic, interactive situation is portrayed in Figure 1.

The Project Manager's Tool Set

The obvious question to be posed now is: How does the project manager cope with this rather frightening situation? Besides having nerves of steel, the project manager has a tool set at his disposal. His tools are the experienced people in the functional areas that are needed to accomplish the acquisition job. These functional areas are business management, technical management, configuration management, procurement and production, integrated logistic support, and product assurance and test (see Figure 2). The description of each of these areas and the interrelationships between them throughout the

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[1] This designation also includes product managers, program managers, and commodity managers.

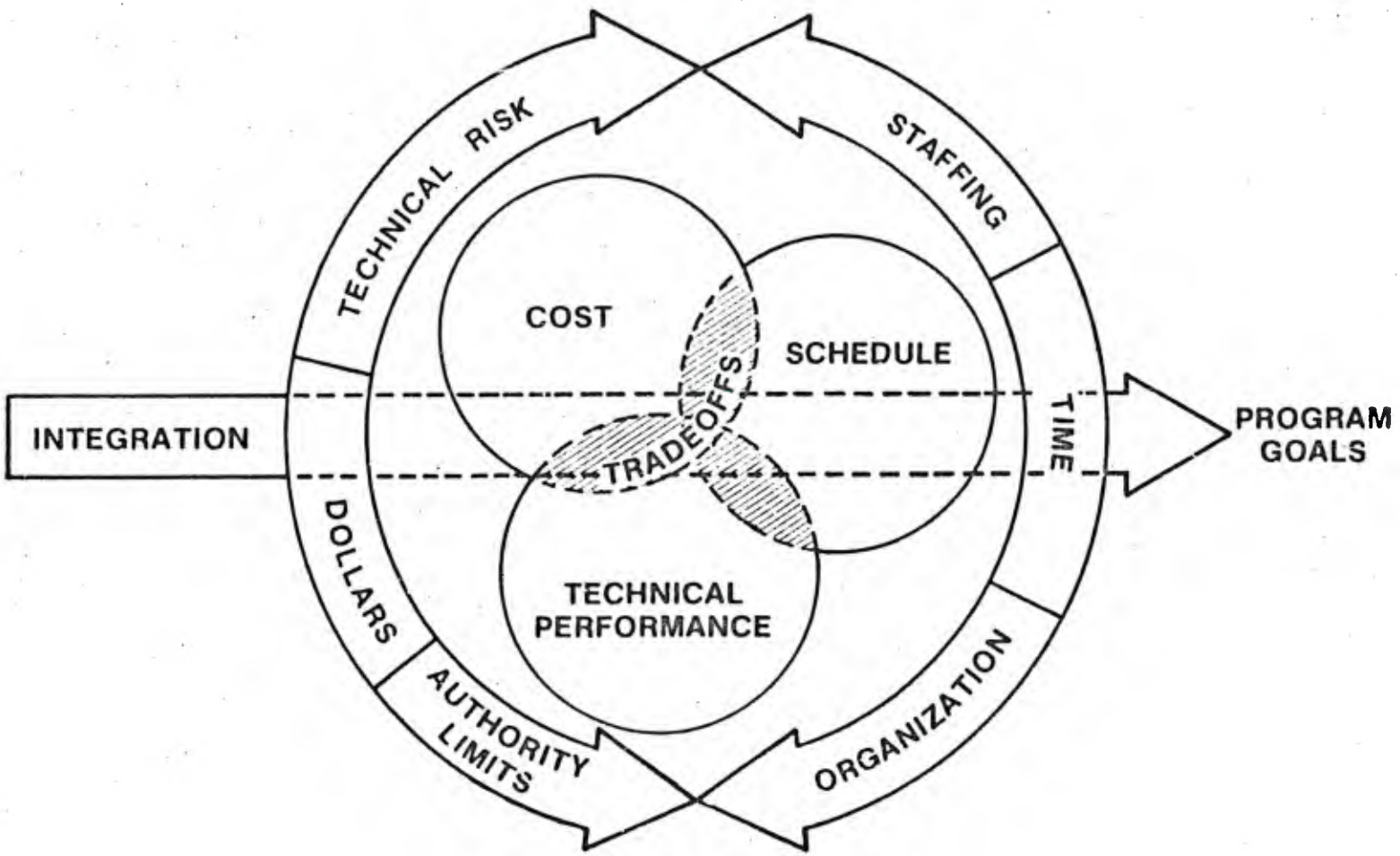
TECHNICAL RISK
STAFFING
COST
SCHEDULE
TRADEOFFS
INTEGRATION
TIME
PROGRAM GOALS
TECHNICAL PERFORMANCE
DOLLARS
AUTHORITY LIMITS
ORGANIZATION

Figure 1

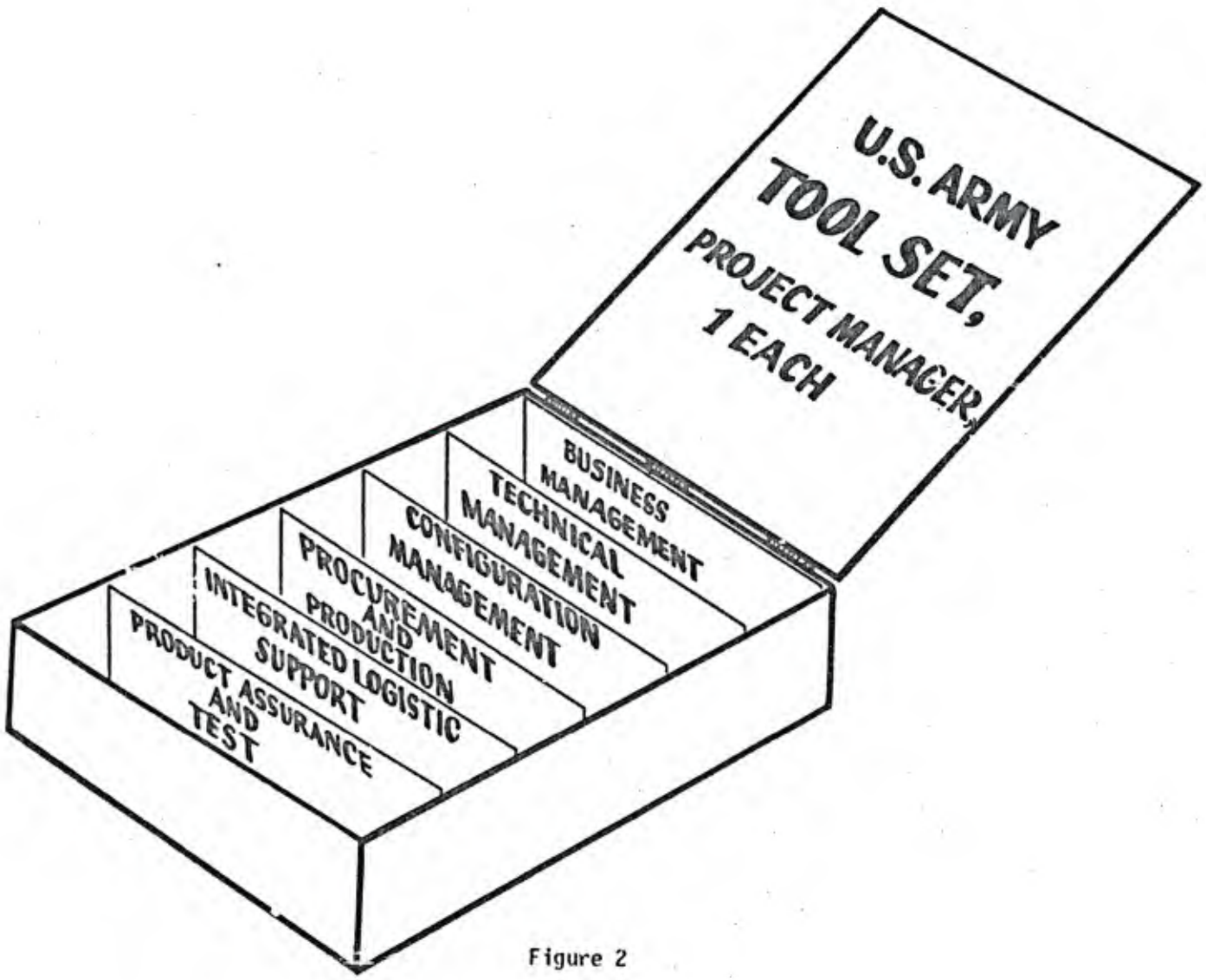
U.S. ARMY
TOOL SET,
PROJECT MANAGER,
1 EACH
BUSINESS MANAGEMENT
TECHNICAL MANAGEMENT
CONFIGURATION MANAGEMENT
PROCUREMENT AND PRODUCTION
INTEGRATED LOGISTIC SUPPORT
PRODUCT ASSURANCE AND TEST

Figure 2

acquisition process is, unfortunately, a task beyond the scope of this paper. Because of the concern of this author that product assurance and test is the least understood of these areas among project managers, this paper will focus on the product assurance and test function.

Purpose The purpose of this paper is to develop a basis for understanding, from a systems engineering viewpoint, the process of accomplishing product assurance and test functions during Army acquisition programs. To achieve this purpose, a management guide for Army project managers is developed. This guide describes the product assurance and test work breakdown structure and shows how this structure interfaces with the overall acquisition process.

Intended Use The guide is intended to be used by project managers to obtain an overall perspective of the management aspects of the product assurance and test function. It emphasizes what a manager needs to know and do about product assurance and test as he utilizes this functional tool to help him achieve his program goals. In this regard, the guide uses a minimum of the technical jargon and acronyms of the practioners.

Organization of the Guide The remaining sections of this paper are organized in the following fashion:

- Section II. What is product assurance and test - the philosophy and need.
- Section III. How product assurance and test fits into the acquisition process - the integration into the acquisition framework.
- Section IV. The Work Packages - What work has to be done.

- Section V. How the work gets done - organizing, staffing, budgeting and programming aspects.
- Section VI. Management Considerations - planning and control.

SECTION II

WHAT IS PRODUCT ASSURANCE AND TEST?

A Basis for Definition

Setting aside any complicating factors for the moment and relying on Webster's New Collegiate Dictionary, one can begin to construct a definition of the product assurance and test function by examining the implicit meaning of the individual words in the phase. A "product" is something produced, that is, given being, form, or shape. "Assurance" is the act of assuring, to give confidence to, to make certain the attainment of. Test is to "apply a critical examination, observation, or evaluation as a means of analysis or diagnosis." Based on these meanings, the following definition is posed:

- Product Assurance and Test Function - a planned and systematic pattern of all actions necessary to provide adequate confidence that the product will perform satisfactorily in service.[2]

Some Amplifications

There are two aspects of this definition that require some elaboration. First, consider the phrase "systematic pattern of all actions." This phrase means that the product assurance and test function can be viewed as a process which is applied to a system throughout the system's life cycle. This process idea is a key factor in understanding the function. The function is not a series of unrelated tasks performed at different milestones during materiel acquisition. Instead, the function consists of a logical sequence of task elements that begin during the conceptual phase. Each task element

[2] This definition is adapted from that for "quality assurance" stated in AMCP 706-100, "Design Guidance for Producibility," August 1971.

lays the ground work and serves as a building block for subsequent task elements. Thus, the function must be applied at the very outset. Its effectiveness is reduced considerably if introduced at midstream in the acquisition process.

The second aspect is the phrase "to provide adequate confidence." The ideal situation in acquisition would be to know for certain, or without a doubt, that our system would work perfectly when it was deployed. But, as Mark Twain said, only two things in life are certain - death and taxes. With apologies to Mr. Twain, another certain thing is that acquisition programs will have problems that were not anticipated. The project manager lives with risk and uncertainty. Basically, his entire job can be viewed as one of defining areas of risk and uncertainty and taking actions to reduce these areas to a tolerable level. Notice the emphasis is on reduction of risk and uncertainty - not elimination. Elimination of all risk and uncertainty would result in a state of certainty, which is impractical if not impossible. Here is where the notion of confidence is helpful. The project manager needs to have a sense, or feeling, that he has reduced risk and uncertainty to levels where he can continue the acquisition program. Confidence can be based on judgement or on facts and figures. The former is subjective and the latter is objective. Whether subjective or objective, confidence must be passed on to higher levels, such as decision bodies like the Army and Defense Acquisition Review Councils. Application of the product assurance and test function can help identify areas of risk and uncertainty and assess these areas for confidence that risk and uncertainty have been reduced to acceptable levels.

The Need

Central to the understanding of the function itself is the understanding of the need for the function in the acquisition process. From a project management viewpoint, the product assurance and test function can bridge the gap between system requirements and user satisfaction, as shown in Figure 3, where the user is the Army troop in the field. This perception is based on the premise that the system requirements are derived from the users' needs. In this context, the project manager needs a degree of confidence that his acquisition strategy is or is not resulting in the procurement of a system which will enjoy user satisfaction. Product assurance and test can be viewed as a management control tool by which this confidence is achieved.

BRIDGING THE GAP

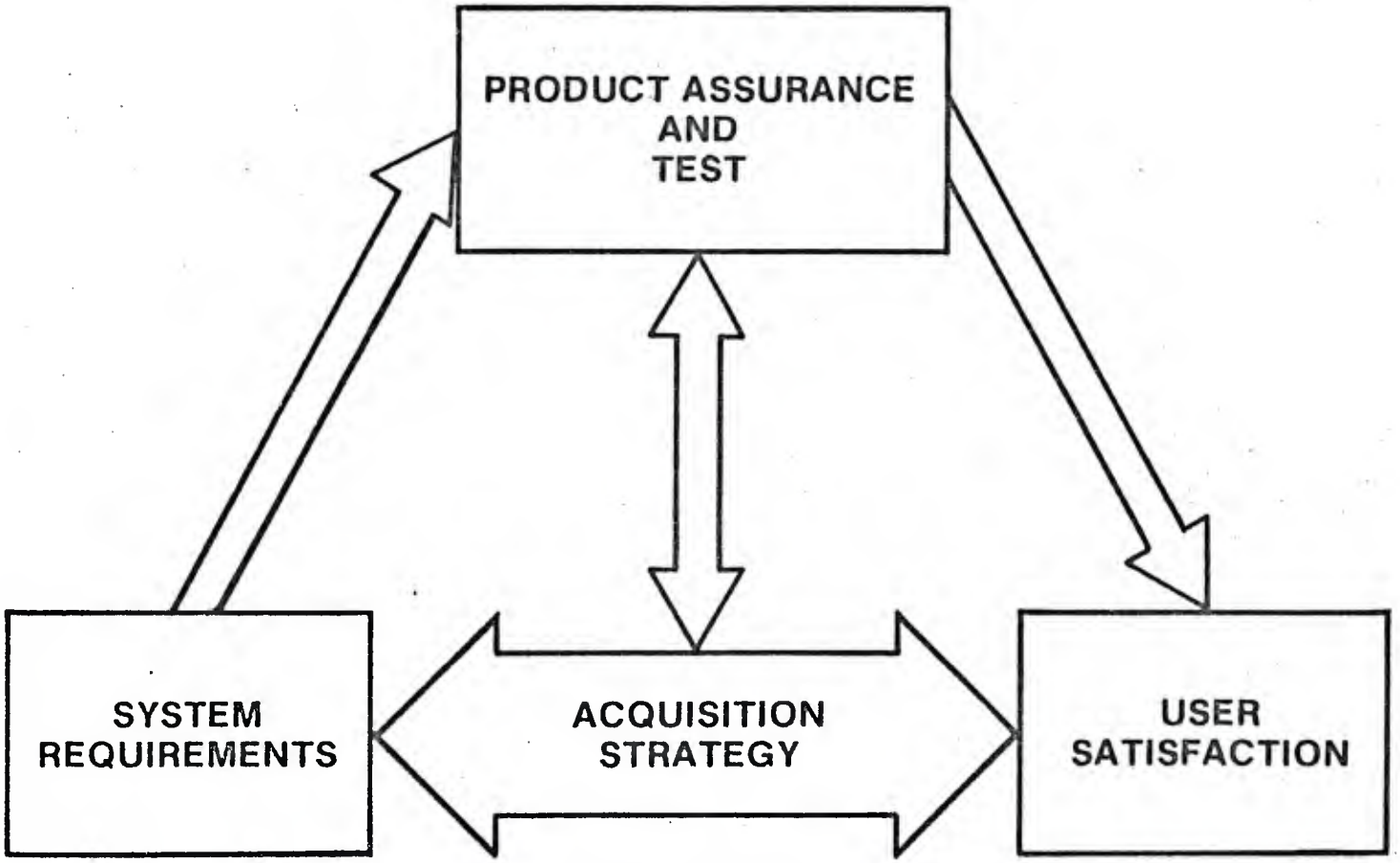

Figure 3

SECTION III

HOW PRODUCT ASSURANCE AND TEST FITS INTO THE ACQUISITION PROCESS

OMB Circular A-109

Substantial changes in the acquisition process were directed by the Office of Management and Budget (OMB) in October 1976 with the issuance of OMB Circular A-109.[3] This circular contains the following management objectives, among others:

- Ensure that each major system fulfills a mission need, operates effectively in its intended environment, and demonstrates a level of performance and reliability that justifies expenditure of limited resources.
- Ensure appropriate trade-offs among investment costs, ownership costs, schedules, and performance characteristics.
- Provide strong checks and balances by ensuring adequate system test and evaluation.
- Maintain a capability to assess cost, schedule and performance achievements against predictions for input to key decision points and make new assessments where variances occur.[4]

The Acquisition Process Today

DOD implemented the changes directed by Circular A-109 by issuing DOD Directive 5000.1 on 18 January 1977.[5] This directive basically defines the materiel acquisition process for major systems in the following manner:

- Need Statement - Major acquisition programs will be based upon an approved Mission Element Need Statement (MENS). The MENS will describe the need against a mission and this need will be stated in operational terms.

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3 OMB Circular A-109, 5 April 1976, Major System Acquisitions.
4 Ibid, pp 4-5.
5 DODD 5000.1, 18 January 1977, Major System Acquisitions.

- Phases - An acquisition program will progress through four sequential phases. These are Conceptual, Validation and Demonstration, Full-Scale Engineering Development, and Production and Deployment.
- Milestones - There are four key milestones in the process. These are:
  - Milestone 0 - Approval of MENS.
  - Milestone I - Approval of alternative system design concepts.
  - Milestone II - Approval of recommended alternative for system development.
  - Milestone III - Approval of production and deployment.
- Decision Reviews - For a major system, there are three Defense Acquisition Review Councils (DSARC). These are:
  - DSARC I - Approval to enter Validation and Demonstration Phase.
  - DSARC II - Approval to enter Full-Scale Engineering Development Phase.
  - DSARC III - Approval to enter Production and Deployment Phase.

The process is graphically portrayed in Figure 4. While the emphasis is placed on major system acquisitions,[6] DODD 5000.1 states that the acquisition policies therein should be used as guides in the management of all acquisition programs. This paper will focus on those product assurance and test tasks required for major system acquisition; however, it should be recognized that the task principles can also be applied to non-major system acquisitions. The tasks will be the same, but the scope of effort required will be less for non-major system acquisitions.

Work Breakdown Structure Approach

The product assurance and test function can be broken down into definable work packages. These work packages have unique objectives and distinct task

[6] Defined as a system which will require expenditure of over $75 million in Research, Development, Test and Evaluation funds or $300 million in Procurement funds.

LIFE CYCLE OF MAJOR SYSTEM ACQUISITIONS

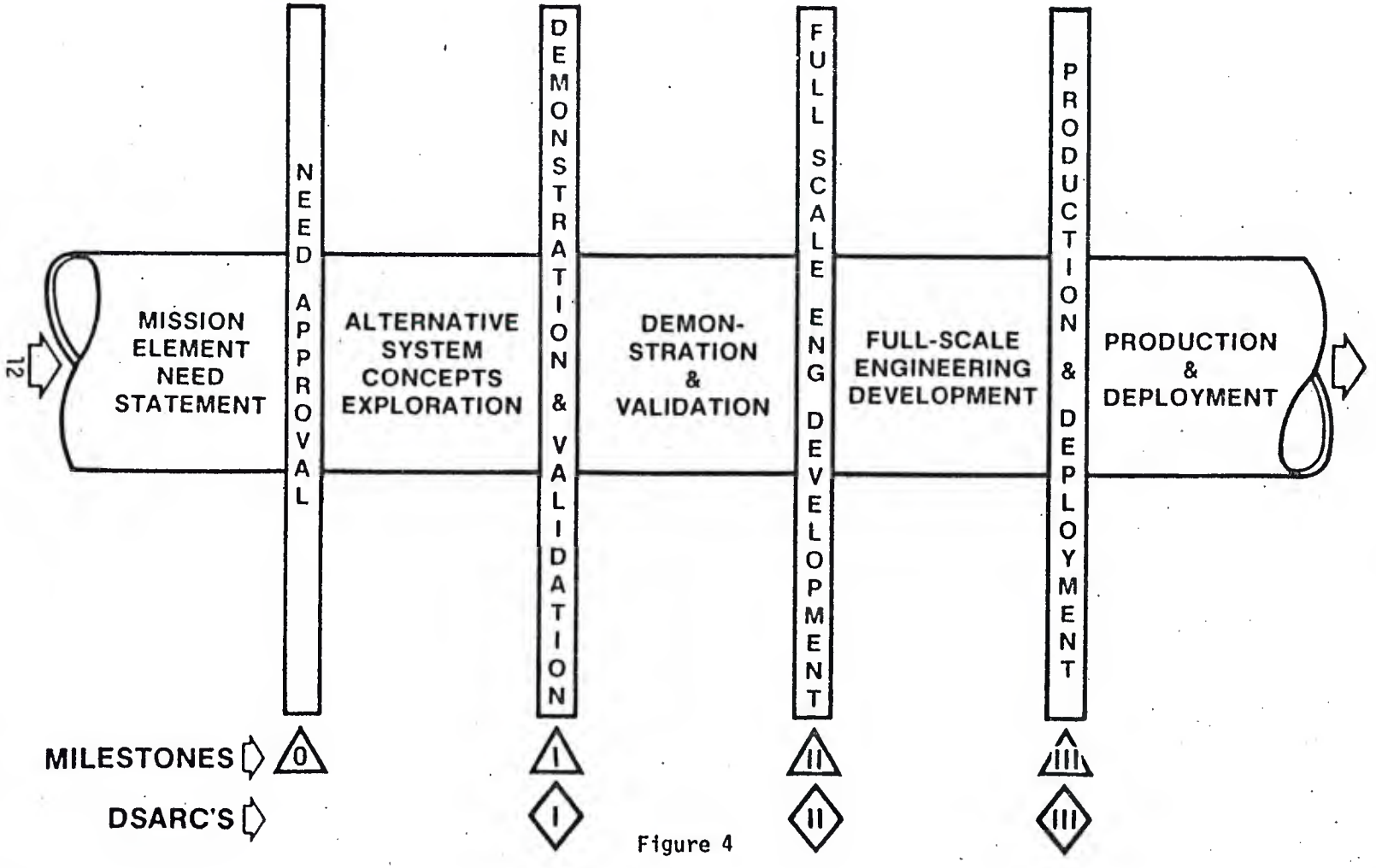


Figure 4

elements associated with them. Each work package can be viewed as a sub-element of the overall product assurance and test program, which is a sub-element itself of the system acquisition program. This approach permits the development of a work breakdown structure for the function, which can be integrated into the work breakdown structure for the system acquisition program. This concept is shown in Figure 5. The integration of the functional structure with the hardware structure will be discussed in Section IV.

Functional Objective

A word about the product assurance and test objective is appropriate before defining the work packages. The objective of the function is to assure user satisfaction. This objective is accomplished by the following activities:

- Structuring realistic and attainable reliability, availability, and maintainability (RAM)[7] requirements.
- Considering RAM characteristics in system design.
- Designing controls to assure system meets design intent.
- Utilizing economical and realistic test designs and integrated testing.
- Detailed attention to quality of initial and follow-on production, software, technical data, repair parts, supply, maintenance, and foreign sales materiel.
- Development and application of efficient metrology and calibration procedures and equipment.
- Assessment of system status and problems throughout the acquisition process.

These activities are used as the basis for defining the work packages.

[7] This acronym will be used for the remainder of this paper.

WORK BREAKDOWN STRUCTURE APPROACH

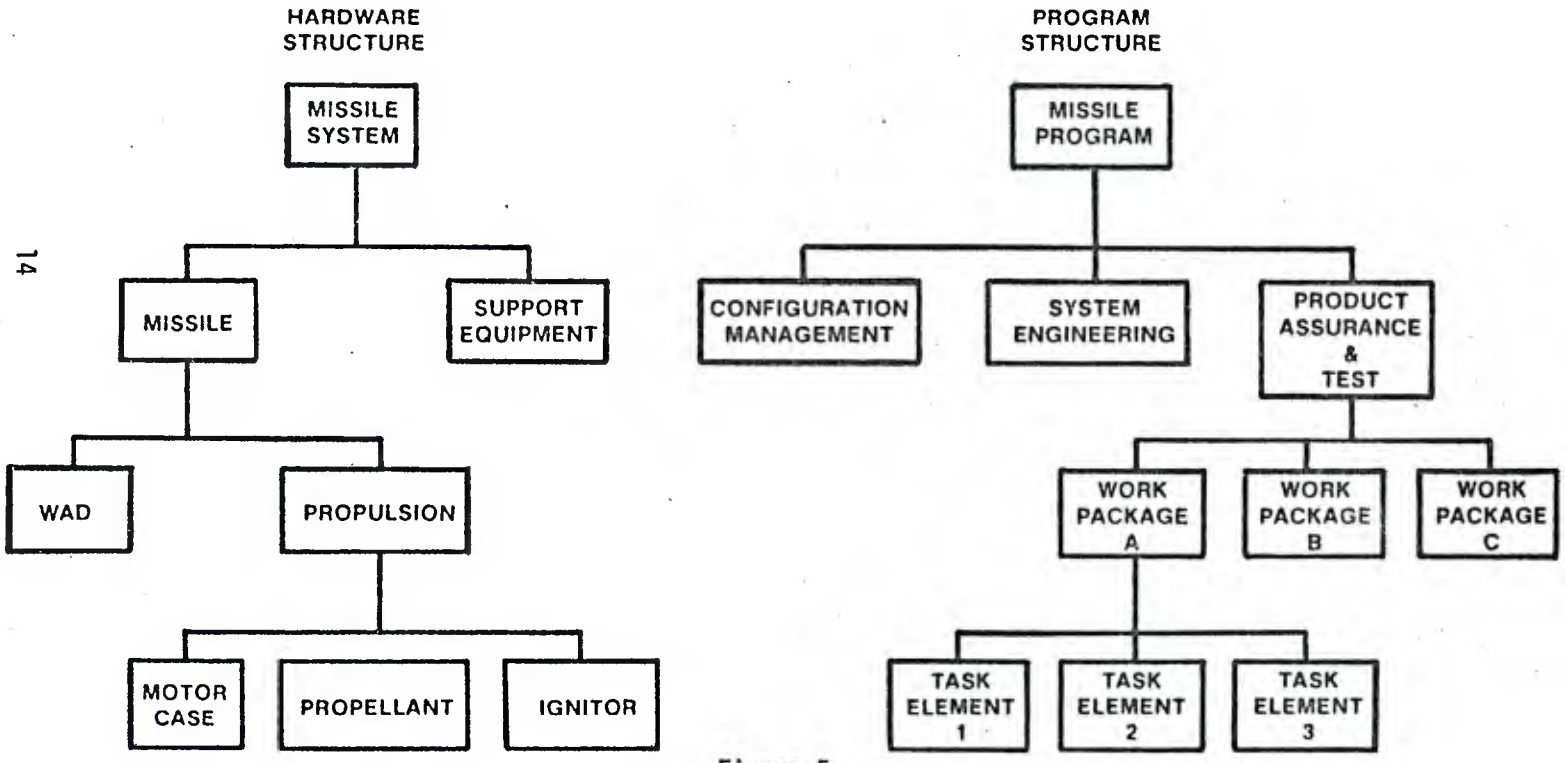


Figure 5

Functional Work Packages

At the present time, the product assurance and test function consists of fourteen work packages. These packages and a brief definition of each are listed below:

- RAM Requirements - Those activities required to assure that RAM requirements are realistic, attainable, properly stated, and capable of test and assessment.
- RAM Engineering - Those engineering activities required for the proper consideration of RAM characteristics in the design process.
- Quality Engineering - Activities associated with the development of design acceptance provisions in Section 4 of system specifications and the design of special acceptance inspection equipment.
- Test Management - Those activities required for integrated testing, including test design; management of resources, facilities and equipment for tests; test evaluation; and test program management.
- System Assessment (Development) - Activities related to the assessment of system status and identification of problem areas during the Conceptual, Validation and Demonstration, and Full-Scale Engineering Development Phases.
- Initial and Follow-on Production Quality - Activities intended to assure that the production item conforms to product specifications.
- Computer Software Quality - Activities related to achieving an acceptable level of quality in computer software.
- Technical Data Quality - Those activities designed to assure a high level of quality in technical data delivered under terms of contracts.
- Repair Parts Quality - Activities to assure that repair parts procured for system support exhibit the required quality levels achieved in initial production.
- Supply Quality - Those activities for assuring that major and secondary replacement items exhibit acceptable quality levels when received at depots and when shipped from depots.
- Maintenance Quality - Activities which assure that depot maintenance does not compromise materiel quality.

- Foreign Sales Quality - Activities which assure that materiel procured by foreign customers conforms to quality standards.
- Metrology and Calibration - Activities associated with the development of calibration equipment and the performance of world-wide calibration services.
- System Assessment (Deployment) - Activities for the assessment of systems in field use to identify system status and problem areas for corrective actions.

Work Packages - Relationship to Acquisition Process

The relationship of these fourteen work packages to the acquisition process is depicted in Figure 6. The shaded areas of this matrix indicate the phase during which the individual work packages must be performed. Examination of this matrix indicates the following relationship between work packages and the acquisition phases:

- Conceptual
  - RAM Requirements
  - RAM Engineering (Planning efforts)
  - System Assessment (Development)
- Validation and Demonstration
  - RAM Engineering
  - Test Management
  - System Assessment (Development)
  - Computer Software Quality
  - Metrology and Calibration
- Full-Scale Engineering Development
  - RAM Engineering
  - Quality Engineering
  - Test Management
  - System Assessment (Development)
  - Initial & Follow-on Production Quality (Planning)
  - Computer Software Quality
  - Technical Data Quality
  - Metrology and Calibration

FUNCTIONAL RELATIONSHIP TO ACQUISITION PROCESS

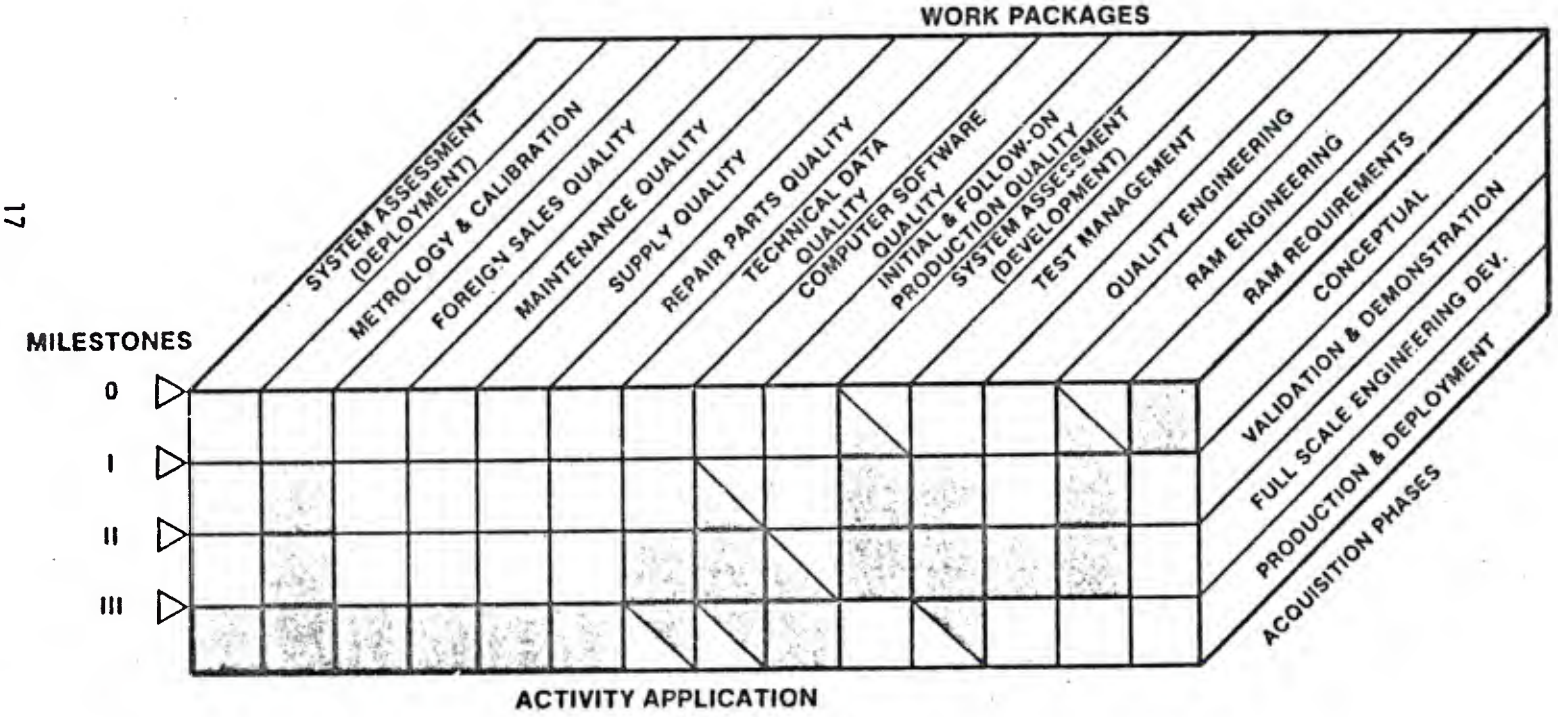


Figure 6

- Production and Deployment
  - Test Management (Production Tests)
  - Initial & Follow-on Production Quality
  - Computer Software Quality
  - Technical Data Quality
  - Repair Parts Quality
  - Supply Quality
  - Maintenance Quality
  - Foreign Sales Quality
  - Metrology and Calibration
  - System Assessment (Deployment)

These relationships will be applicable to most system acquisition programs. They can be used as a guideline in program planning for the four acquisition phases. In Section IV, the contents of the individual work packages are discussed.

SECTION IV

THE WORK PACKAGES

Purpose The product assurance and test function was defined in Section II. In Section III, we discussed how the function fits within the acquisition process in terms of the functional work packages. In this section, these work packages are discussed in terms of what task elements have to be performed for each. The intent here is not to get into an exhaustive "how to" exercise, but instead, the objective is to provide project managers with an appreciation for the type and scope of work to be accomplished under these work packages.

Hardware and Functional Work Breakdown Structure Integration Before describing the task elements of the individual work packages, an understanding of how the hardware and functional work breakdown structure is integrated will be helpful. The key consideration is how the functional work packages are applied to the hardware structure. The hardware structure is developed by a logical process of breaking down the system into work packages that define unique hardware elements for which work can be easily applied and accounted. These hardware elements usually satisfy some end use function. They are usually those specification items that are referenced directly in a contract or any reparable item designated for separate procurement. As such, these hardware elements are designated as configuration items and are subject to configuration management. It is to these configuration items that the functional work packages are applied. Thus, the

functional work may be applicable to a major sub-assembly, component, or repair part; depending upon the degree to which the item is subjected to configuration control.

RAM Requirements

This work package is applied at the outset during the Conceptual Phase. Its application is usually at the system level where RAM requirements are generally applicable. The objective is to establish cost effective, realistic and feasible requirements. This is accomplished by validating the quantification of requirements. A key task element is the development of a RAM baseline[8] for the system to determine what are the feasible RAM levels. The resulting analysis is documented in a rationale annex to the requirements document. Failure definitions and scoring criteria are also developed to provide the groundrules for future analyses and interpretation of test results. These activities are critical, since they assure that the program is not saddled with unrealistic, unattainable RAM requirements from the beginning.

RAM Engineering

Planning for this work package begins during the Conceptual Phase. The engineering effort is applied during the design activities that occur during the Validation and Demonstration and Full-Scale Engineering Development Phases. The objective is to achieve RAM requirements during development. The task elements for this work package are:

---

8 RAM baseline is a quantitative assessment, based on data from similar systems and engineering judgements, of the state of the art for RAM, which can be used in evaluating RAM requirements for the new system.

- RAM Growth Planning and Management - This task involves establishing planned values for RAM at successive points in the system acquisition, assessment of RAM achievements at these points, predictions of RAM growth trends, and the identification of time and resources needed to achieve the required RAM levels.

- RAM Input to Coordinated Test Plans - This input consists of RAM requirements, failure definitions and scoring criteria, sample size, test design, testing risks, environmental profiles, operational mode summary and mission profiles and the data collection scheme. Test data are analyzed and results evaluated.

- RAM in Contracts - This task element calls for appropriate RAM considerations to be inserted into significant development and production solicitations and resultant contracts. The considerations involve requirements for hardware RAM, RAM test and demonstration, RAM programs, RAM management controls, and incentives and warranties.

- RAM Design Evaluation and Analysis - Application of design practices for RAM achievement are the crux of this element. These practices include parts qualification, stress analysis, part derating, worse case analysis, failure modes and effects analysis, component control, in-depth design reviews, predictions and allocations, and failure analysis.

Quality Engineering

Quality engineering activity takes place during the Full-Scale Engineering Development Phase. The objective is to establish controls to assure the system meets the design intent. Quality engineering task elements are applicable to the total system, major assemblies, repair parts, and critical processes. These tasks develop criteria for assuring conformance with design intent during production, storage, and depot maintenance operations. The task elements include the development of quality standards, preparation of quality assurance provisions of specifications, design of inspection equipment, test design for configuration item qualification and control, development of serviceability standards for materiel in storage, preparation

of quality assurance provisions for rebuild/overhaul specifications, and development and application of nondestructive testing techniques.

Test Management

Test Management activity begins in the Validation and Demonstration Phase and ends in the Production and Deployment Phase. The objective is to execute an integrated test program that provides sufficient testing consistent with the acquisition objectives and time and resource constraints. Tests involve those that influence design, such as contractors' engineering development testing, and those that assess design, such as Government development/operational tests. In-house laboratory testing for component qualification, first article, and failure analysis is also included in this work package. The emphasis is on the integration of contractor and Government testing as well as on integration of development and operational testing consistent with the objectives of each type of testing. The overall purpose of testing is to reduce risk. This purpose generally drives the amount of testing that has to be done. However, when unknowns arise that were not anticipated, additional testing beyond that programmed may have to be done. This situation usually requires the prudent manager to hedge by holding a management reserve as a contingency. The key task elements for test management include the following:

- Test Objectives - Test objectives are developed for the system acquisition program to guide test planning.
- Test and Evaluation Master Plan (TEMP) - The TEMP is the master plan which documents all requirements, tasks, resources, schedules, milestones, facilities, equipment, and coordination points for the

acquisition testing and evaluation program. It serves as the basis for programming and budgeting decisions related to testing. Also, it is used as a control document to monitor commitment of resources and test progress. The preparation of the TEMP is initiated in the Validation and Demonstration Phase and is updated as new information and planning estimates become available. The importance of the TEMP in achieving an effective and economical test program should be recognized by project managers.

- Test Resources - Resources required for testing, such as people, facilities, and equipment, are identified and actions taken to make them available when they are needed.

- Testing Focal Point - A Test Integration Working Group is formed. This group is chaired by the project manager's representative and includes representatives from cognizant agencies, such as TRADOC, OTEA, TECOM, and AMSAA. The group accomplishes test planning, design, and data scoring.

System Assessment (Development)

The objective of system assessment in development is the quantification and analysis of system performance in order to track achievement of requirements, predict future results and anticipate shortfalls, identify problems, and verify corrective actions. This task element can be applied to the total system or any of its configuration items. The identification of system parameters for assessment and initial planning occur in the Conceptual Phase, while detailed assessments are performed during the Validation and Demonstration and Full-Scale Engineering Development Phases. The task elements are as follows:

- System Assessment Status Reports - These reports document the results of periodic assessments of key system characteristics, such as reliability, availability, maintainability, and system effectiveness. These key characteristics are typically contained in Decision Coordinating Papers, Army Program Memorandums, Selected Acquisition Reports, Department of Army Program Reviews, and Review and Command Assessment of Projects (RECAP) Briefings. The system assessments permit the quantification of these characteristics and assure consistent reporting to higher authority.

- Data Base - A key element of any acquisition program is the mass of data on system performance generated in contractor and Government testing. It is crucial to program management that this data be carefully organized and controlled due to its importance in assessing program progress and measuring the achievement of requirements. This task emphasizes the orderly collection, storage, retrieval and analysis of program data to support status assessment, problem identification and management decision-making.

- Work Package Assessment - This task involves the detailed technical and engineering assessment of contract work packages in those cases where the contractor's actual cost has significantly exceeded his budgeted cost for the work package. The purpose of this type of assessment is the early identification of technical problems and evaluation of their impact on program costs and schedule. Ideally, it is performed by a Government team, but may be included as a provision of the contractor's scope of work. In the latter case, the contractor should be required to submit a report on findings.

- Quality Readiness Review - This assessment occurs prior to the decision to enter production. Its purpose is to assure that the product, material, and process specifications for the configuration items properly characterize the configuration item for production. Emphasize is placed on the ability to achieve consistency in production through the proper specification of product attributes, control of appropriate materials and processes, and the utilization of efficient and effective tests and inspections for determining product attribute compliance with specification requirements. This assessment should be performed by a Government team.

Initial and Follow-on Production Quality

Initial efforts on this work package begin in the Full-Scale Engineering Development Phase. The objectives are to apply cost effective quality assurance contract provisions, provide confidence in product acceptability, perform first article tests, and assure proper releases of materiel to the field users. Since this work package is an integral part of the production process, its task elements are closely tied to the process of contract award and execution. They can be considered in terms of pre-solicitation, pre-award and post-award activities:

- Contract Requirements - The output of this task provides input to the request for proposal in terms of a contemplated structure of quality assurance requirements for the anticipated contract. These requirements are generally based on the analysis of the technical data package and participation in the physical configuration audit.

- Pre-Award Survey - This survey is usually performed by the cognizant contract administration service component, either Army, Navy, Air Force, or Defense Contract Administration Service. Its purpose is to evaluate the capability of a prospective contractor to comply with the terms of the proposed contract. The particulars for the survey are set forth in Section 1-905.4 and Appendix K of the Armed Services Procurement Regulation (ASPR). An appraisal of the contractor's quality control system is a key element in the survey. The project management office should receive the pre-award survey findings for the contractor who is awarded the production contract.

- Participation in Production Readiness Reviews - DOD Directive 5000.34,[9] Defense Production Management, establishes the policy that production decisions shall be supported by an assessment of the program readiness for production. This assessment is to be based on a formal production readiness review. The purpose of this review is to determine whether the system under development is ready for efficient and economical quantity production, that all important production engineering problems encountered during development have been resolved, and that the contractor has accomplished planning for the production phase. Since quality considerations are deeply imbedded in the production process, it is critical that personnel with quality expertise participate in the production readiness review, and that the readiness of the contractor's quality system for quantity production be thoroughly assessed.

- Initial Production - The quality program provisions of the contract are implemented by the contractor during initial production. The responsibility for monitoring the contractor's implementation and performance of the production quality program belongs to the cognizant contract administration service component. The project management office is responsible for issuing any special instructions to the contract administration service component regarding the administration of the quality provisions. This is accomplished by the Quality Assurance Letter of Instruction. Although monitoring quality is a responsibility of the cognizant contract administration service component, the project or functional support personnel may perform periodic key inspections. These surveys are restricted to an inspection of the product on the production line. Product deficiencies discovered, however, may dictate an overall review of the contractor's

[9] DOD Directive 5000.34, Defense Production Management, signed coordination draft, dated 27 September 1977. As of 27 October 1977, the Directive had not been published.

quality program in conjunction with the cognizant contract administration service component. A post-award conference may also be performed by the cognizant contract administration service component during initial production. The objectives of this conference are to make sure the contractor understands the contract and to inform the contractor of any problems experienced in previous production of the system.

- First Article - A key event in the initial production period is the delivery of the first article produced for Government tests and inspections. The conformance of the first article is a crucial test of the capability of the contractor's production process to deliver a product which meets specification requirements. The tests are performed both in-plant and at Government test grounds. Due to their critical nature, it is advisable to have project or functional support personnel witness these tests.

- Materiel Releases - Once the first article tests have been successfully completed, subsequent production can be delivered to inventory points. This equipment must be certified by the project manager or functional commander for release to field users. The objective is to assure that the user will receive equipment that performs properly and can be supported. The factors that must be considered in a materiel release decision include performance, repair parts, basic issue items, manuals, maintenance equipment, and training.

- Comparison Tests - During volume production, periodic comparison tests should be performed to assure that the production items are compliant with specification requirements. These tests are comparable in scope to the first article tests.

Computer Software Quality

The major activities of this work package occur during the Validation and Demonstration, Full-Scale Engineering Development, and Production and Deployment phases. The objective is to assure the development and procurement of computer software that is reliable and operationally effective. Due to its special differences from hardware, careful attention has to be paid to computer software development and procurement. The most critical process is the design and testing of the software. Task elements of this work package are as follows:

- Requirements Quantification - Software design is more of an art than a science. No two programmers are likely to approach a design in the same manner. Thus, it is essential that some measure of software reliability be defined as a design requirement. The definition of a reliability requirement should occur in the Validation and Demonstration phase where initial software design approaches are being developed. Care should be taken to assure that the requirement is realistic and relevant to the software's functions. It should also be stated in a manner that permits its measurement during testing.

- Software in Contracts - This task element applies to contracts in the Full-Scale Engineering Development phase. In these contracts, software aspects must be defined in the scope of work, system specification, and data requirements. The scope of work should specify all the software-related tasks to be performed under the contract. Software requirements and compliance criteria is spelled out in the system specification. Documentation of the software design logic should be required as a deliverable item. This documentation is essential for controlling software configuration.

- Software Evaluation and Analysis - This task is a never-ending one for software. During development, design reviews are the principal means of evaluating the progress of software design efforts. Once formal configuration control is invoked, each software change must be carefully evaluated and tested to assure it does not adversely impact the total program.

- Testing - Software testing is critical in proving that the software will reliably perform its intended function. The testing should be performed in an operationally realistic environment with representative hardware. The testing procedures and ground rules for assessing test results must be documented and agreed to by all cognizant agencies. The software design should be complete before demonstration type testing is conducted.

Technical Data Quality

This work package is performed during the Full-Scale Engineering Development and Production and Deployment phases. The objective is to obtain a high quality technical data package for use in competitive procurements of future buys of production systems and secondary items for supply support. The task elements include structuring quality provisions for technical data as inputs to solicitations and contracts, evaluation and control of technical data, and verifying technical data accuracy during the physical configuration audit.

Repair Parts Quality

The objective of this work package, which is performed during the Production and Deployment phase, is to assure that reprocurements of repair parts exhibit comparable quality as the initial production items. To accomplish this, technical data for repair parts must contain quality requirements and acceptance provisions which will assure the delivery of quality materiel. Excessive use of waivers and deviations to facilitate delivery must be avoided. Acceptance tests should be designed to assure repair part compatibility with overall system requirements.

Supply Quality

The quality of supply items furnished field users is a subject deserving continuing concern. Performed during supply operations in the Production and Deployment phase, the objective of this work package is to assure that supplies entering the inventory and being issued to troops possess an acceptable level of quality. The task elements of this work package are usually performed at the depot which receives and issues supplies. The first task element is the establishment and operation of a system for inspecting incoming supplies from production sources. The second element is the establishment and operation of a system for inspecting supplies as they are issued to field users. Both these systems must utilize lot sampling and inspection criteria which reflects production specifications.

Maintenance Quality

This work package is performed during the Production and Deployment phase and is applicable to maintenance activities performed at the depot level

and field maintenance levels performing extensive repair/rebuild work. The objective is to assure that such maintenance does not degrade equipment quality. The task elements include development of quality standards for inspection and acceptance of rebuilt and overhauled equipment, performance of in-process inspection, conducting acceptance inspections and tests, and analyzing and evaluating the quality of maintenance.

Foreign Sales Quality This work package only applies to items of equipment procured for foreign customers. Its objective is to assure that the equipment delivered to foreign customers exhibits acceptable quality. The initial task element is the audit of documents for Price and Availability Requests and Letters of Offer and Acceptance to assure accuracy and completeness of the required entries. Once the contracting process is started, appropriate quality provisions are included in solicitations and contracts consistent with the foreign customer's desires. Prior to shipment, inspections are performed to assure materiel compliance. After delivery to the foreign customer, quality assurance teams perform in-country visits to resolve any complaints received from the customer when he takes delivery.

Metrology and Calibration Metrology and calibration tasks are performed during the acquisition phases of Validation and Demonstration, Full-Scale Engineering Development, and Production and Deployment. The objective of this work package is to assure that adequate metrology and calibration capabilities are developed during the acquisition process. This is accomplished by identifying metrology and

calibration needs during the design activity. Alternatives are developed for satisfying tnese needs by using either system-dedicated calibration equipment or through utilization of multi-purpose equipment. A decision must be made early in the program whether to develop the needed equipment or procure existing commercial equipment which will satisfy the needs. The equipment is then procured or developed and tested in conjunction with the hardware testing. Provisions must also be made for the training and deployment of personnel specialists to perform the calibration functions. At this point, consideration should be given to the utilization of facilities of the other services. Once the system is deployed, a program for performing the required calibration cycles has to be developed and implemented.

System Assessment (Deployment)

The final work package to be discussed is that for system assessment of deployed equipment. A key aspect of the product assurance and test philosophy of assuring user satisfaction is that of knowing how the equipment is performing in the field and what problems the field user has with it. This activity is an essential prerequisite to developing and implementing effective corrective actions. Emphasis is placed on the assessment of the <u>total</u> system, which includes hardware performance, logistic support, maintenance support, training, technical manuals, operator performance, operational readiness, safety, and technical support. The task elements for this work package include preparation of system assessment letters, conduct of disciplined reviews, and implementation of RAM improvements on selected equipment.

- System Assessment Letters - This task element requires that the functional commanders conduct annual assessments of those deployed systems which are crucial to the soldier's ability to move, shoot, and communicate. Headquarters, DARCOM establishes an annual schedule for accomplishing these assessments. The functional commanders document their findings in a formal report. This report is forwarded to Headquarters, DARCOM under a personal letter from the functional commander which contains his overall personal assessment of the system's status and problems. The assessment report contains a system improvement plan for correcting any problem areas surfaced by the assessment. Headquarters, DARCOM staff reviews the assessment report and the functional commander's letter is responded to by the Deputy Commander for Materiel Readiness, DARCOM. This process assures management visibility of the status of equipment in the field.

- Disciplined Reviews - The disciplined review is a joint assessment of a fielded system by the operational user command, DARCOM functional commander, and the Training and Doctrine Command (TRADOC). The DARCOM functional command schedules and administers the review. Typically, the reviews will be held at two points in the operational life of a system, after initial deployment (2-3 years) and at the mid-point of the systems estimated useful life. The review is preceded by each of the participants conducting their own assessments of the system. The review is a formal, face-to-face meeting with a structured agenda which features presentations of all participants points of view. It culminates with a jointly approved system improvement plan. This type of review is intended to improve communications with the field user and trainer on problems and improvement actions for operational systems.

- RAM Improvement of Selected Equipment - The payoff of system assessments and disciplined reviews is the identification of initiatives to improve the readiness and reduce operating and support costs for operational systems. Known by the acronym RISE, this task element seeks to utilize a systematic approach for improving the RAM of fielded equipment. A typical RISE program consists of four phases of effort. First, candidates for improvement are identified through assessments. Second, these candidates are analyzed from design and cost viewpoints to determine feasibility and estimated cost savings. Third, the candidates with the greatest potential payoffs are implemented through product improvements or engineering change proposals. Lastly, the improvements are assessed after deployment to verify the degree of readiness improvement or cost savings actually achieved.

SECTION V

HOW THE WORK GETS DONE

Purpose

Now that the reader has an appreciation for the fourteen product assurance and test functional work packages and their task elements, it is appropriate to discuss in this section how the work gets done. The topics to be covered include the organizing, staffing, and budgeting and programming associated with the product assurance and test function.

How Much Work?

Before getting to the specifics on the topics mentioned above, the question of how much work should be done needs to be discussed. The answer that immediately comes to one's mind is that the amount of product assurance and test work that needs to be done will depend upon the situation in which the system acquisition can be expected to take place. In assessing what this situation might be, the life cycle characteristics spectrum should be defined and related to the product assurance and test function. A typical spectrum might be characterized by elements of uncertainty, risk, alternatives, cost, requirements, planning, trade-offs, schedules, and changes. Each of these elements can be viewed as representing a continuum of possibilities and the situational aspects of the acquisition can be located in a relative position on each continuum to develop the overall life cycle characteristics spectrum. In a similar fashion, a continuum for product

assurance and test work can be developed and related to the continuum for each element. This approach is illustrated in Figure 7. For example, more product assurance and test work will have to be done if there is uncertainty, high risk, many alternatives, flexible schedules, vague requirements, flexible planning, open trade-offs, and many changes than if the converse were true. Assessing the acquisition program in this fashion will aid the project manager in determining how much of his resources should be dedicated to the product assurance and test function.

Organizing

There is no single answer to the question of how to organize to accomplish the product assurance and test work. Rather, the answer lies in an assessment of the life cycle characteristics spectrum and making a judgement on the best approach based on the facts of the situation. Generally speaking, the more work that has to be done, the more structured the organization must be. This is an inevitable consequence of having to dedicate substantial resources to the function--resources which must be carefully managed. Thus, the organization should be designed to facilitate degree of management required. There are, however, some approaches which can be used to guide decision-making on what organizational structure to use.

- Project Dedicated - This structure is depicted in Figure 8. In this approach, all the resources needed to perform the work are located within the project itself. The project is autonomous and does not have to rely on the functional command for support. This approach is costly and should only be considered for large, complex projects.

LIFE CYCLE CHARACTERISTICS SPECTRUM

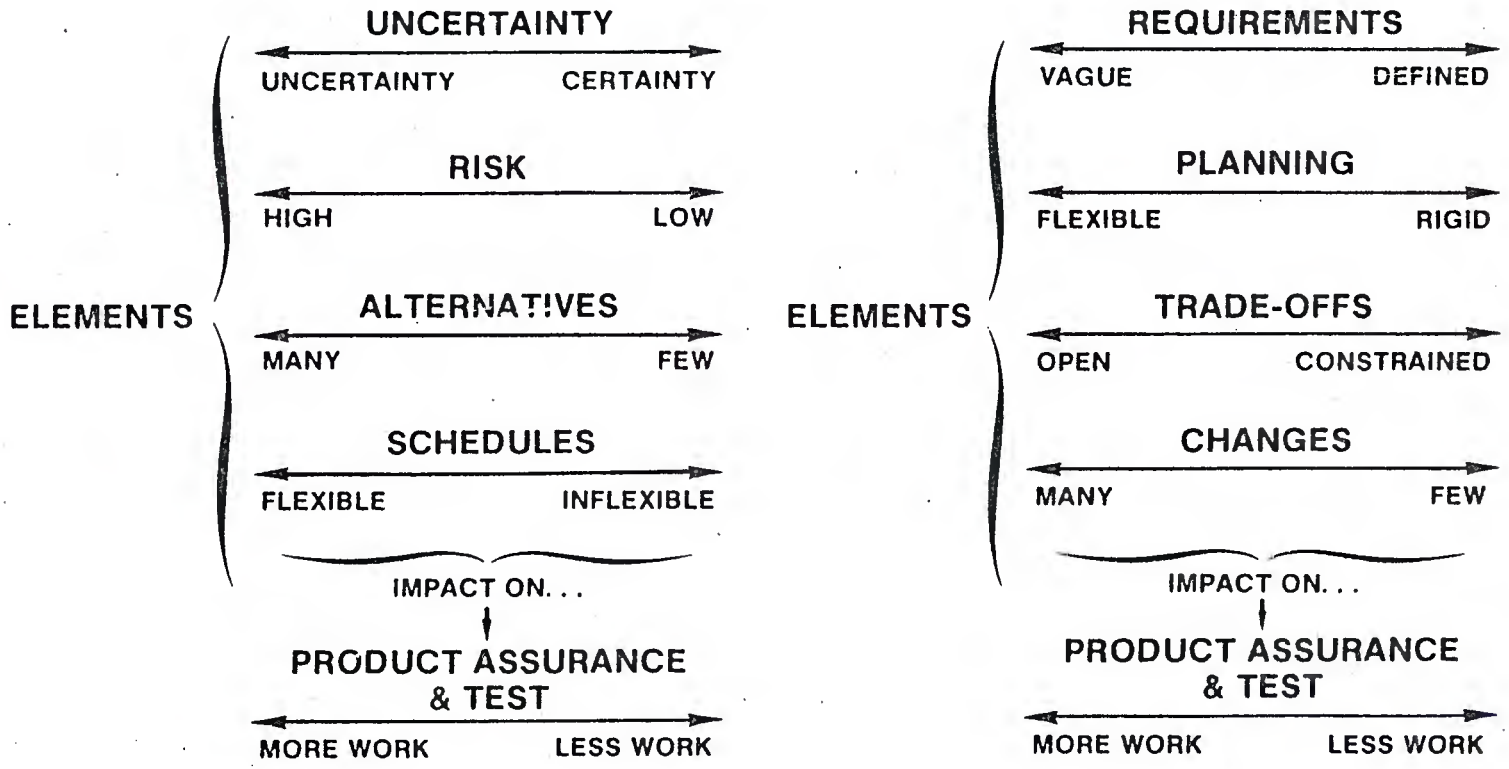


Figure 7

PROJECT DEDICATED

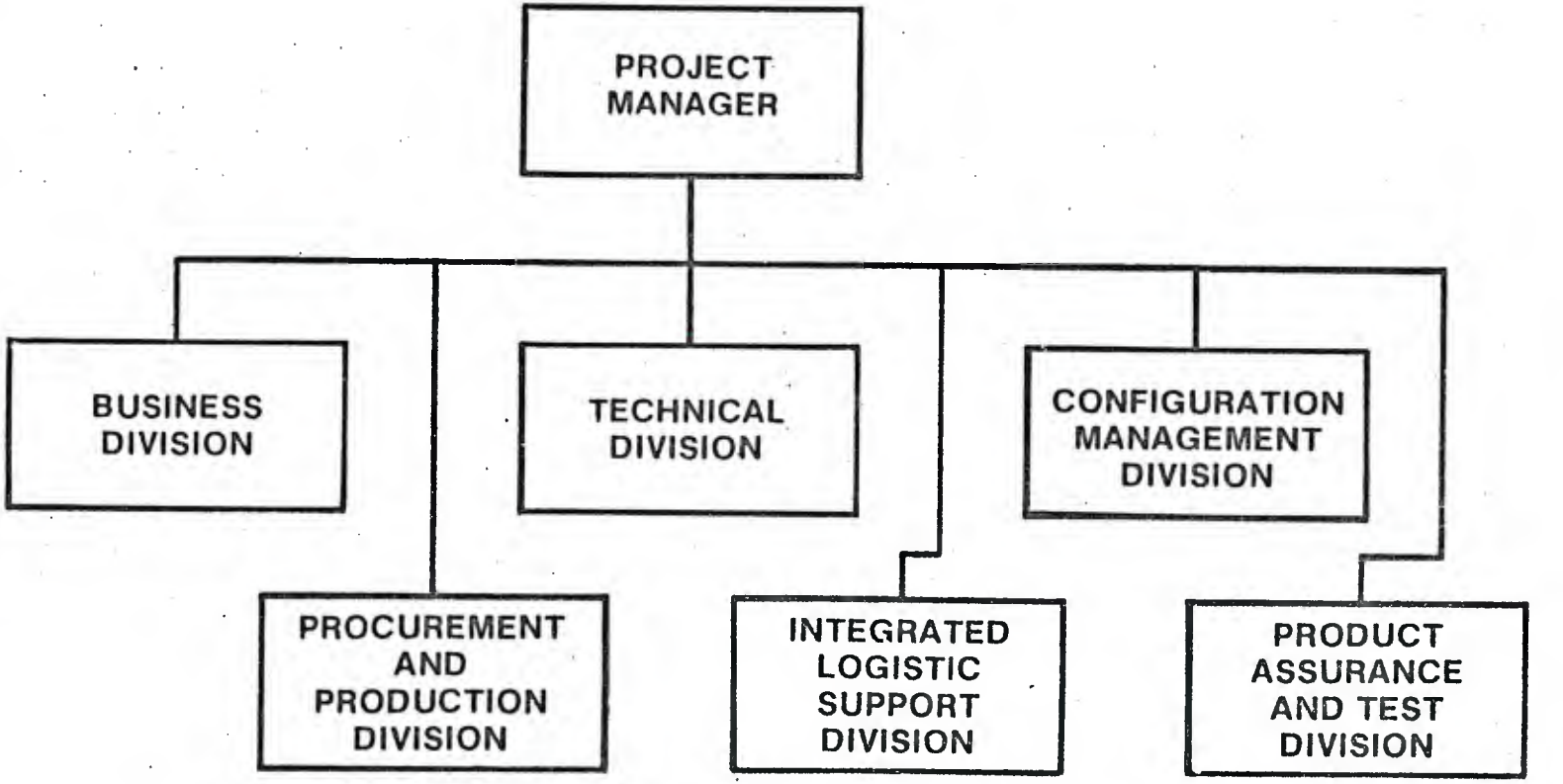


Figure 8

- Project/Functional Mix - Depicted in Figure 9, this approach features a core of functional specialists for management and integration of the product assurance and test effort located in the project office. The predominance of the work is performed by the functional support organization of the functional command. This approach results in less functional duplication but requires a greater degree of integration on the part of the project personnel.

- Project Integrator - This approach, depicted in Figure 10, places a very small core in the project office. Their task is limited to integration of the product assurance and test work with the other functional disciplines. The management and performance of the work must be performed by the functional support organization of the functional command. Under this arrangement, the project manager has less control over the performance of the work.

Again, these are alternative approaches--the best approach will depend upon the situation. As resources become harder to obtain, however, the trend will probably be more toward the project/functional mix and the project integrator approaches.

Staffing

Regardless of the type of organizational approach choosen, the satisfactory accomplishment of the product assurance and test work will depend on staffing that organization with capable people. A few words about the type of skills needed to perform the work might be helpful in staffing decisions. First, one must realize that there is not a separate career field for civilians nor an occupational specialty for military personnel in the field of product assurance and test. If an examination of current product assurance and test organizations were made, one would find a mix of engineers and scientists, mathematicians and statisticians, quality assurance specialists, and various technicians. These personnel have been educated in their

PROJECT/FUNCTIONAL MIX

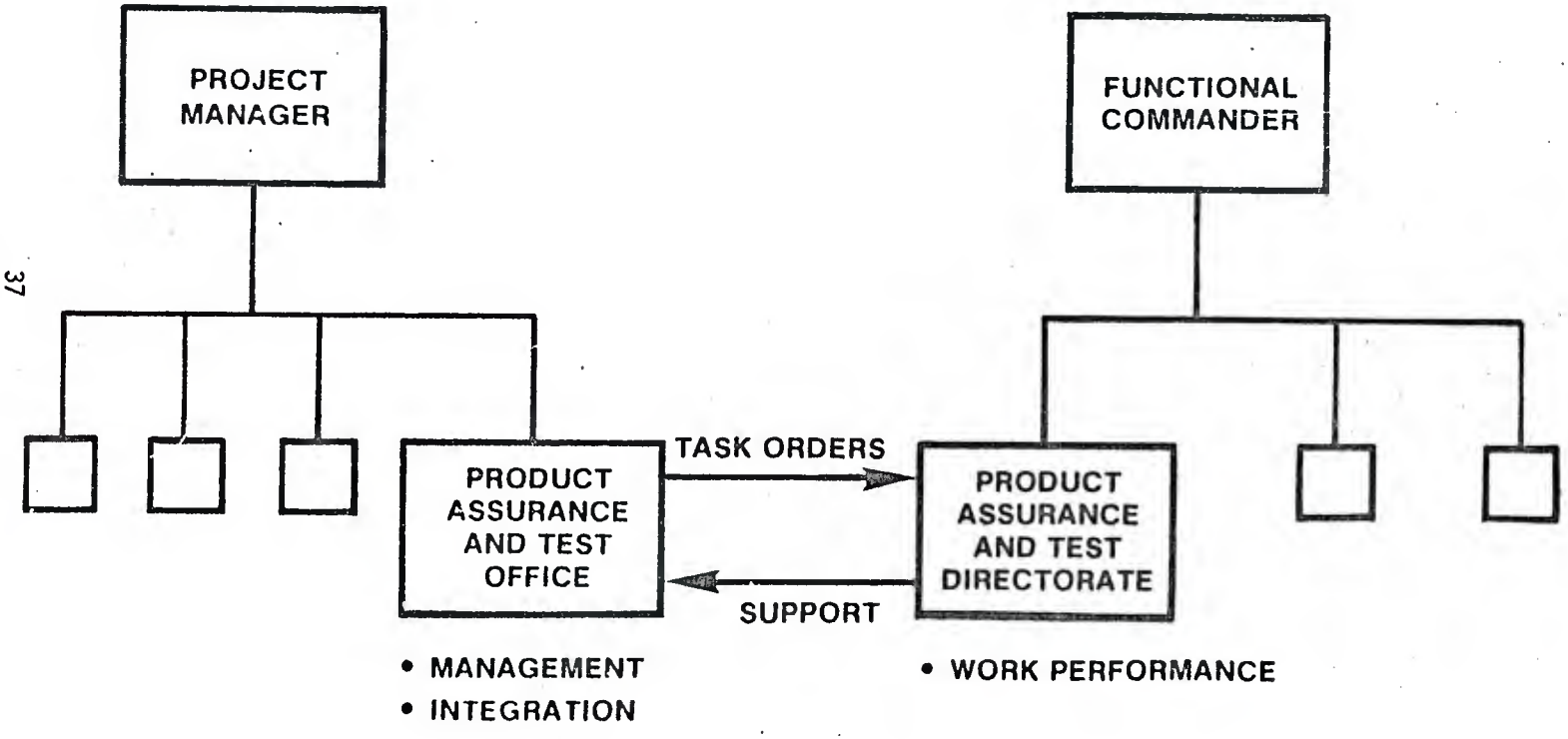


Figure 9

PROJECT INTEGRATOR

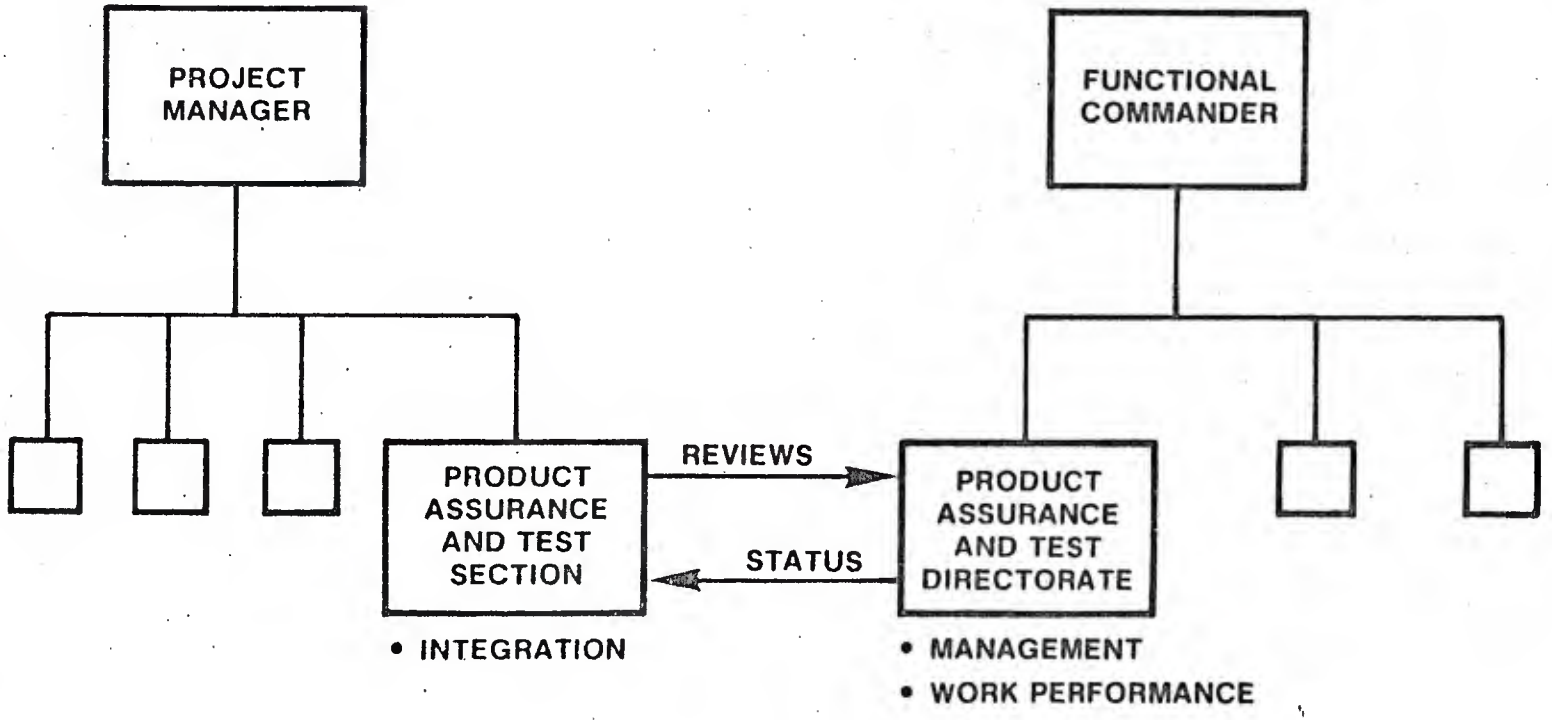


Figure 10

primary specialty and usually have some "hands-on" work experience in that specialty. Some, however, have entered the product assurance and test work directly from their educational experiences. Product assurance and test expertise is usually obtained from formal education in allied disciplines, on-the-job training, or formal Government training in the product assurance and test discipline. In selecting a staff, the key consideration should be an assessment of an individual's potential to perform the work. This assessment should consider the individual's work experience and educational background. Where practicable, an interview is a good method for assessing the individual's inclination and motivation for performing the product assurance and test work. Generally speaking, individuals strong in fact-finding ability and quantitative analysis can perform the work well. Experience with the hardware being developed is not a necessary prerequisite for performing the functional work, but such experience may provide a competitive advantage to the individual who possesses it.

Programming and Budgeting

It almost goes without saying that if funds are not made available, none of the work will be accomplished. Careful programming and budgeting can assure that sufficient funds will be available at the time they are needed. There is not, however, a separate budget line for funding product assurance and test work in the current Army financial structure. The work may be described as the level of effort type, with this effort being directly applied on a specific system acquisition. This is particularly true during the development and production effort. Once an item is out of production, however,

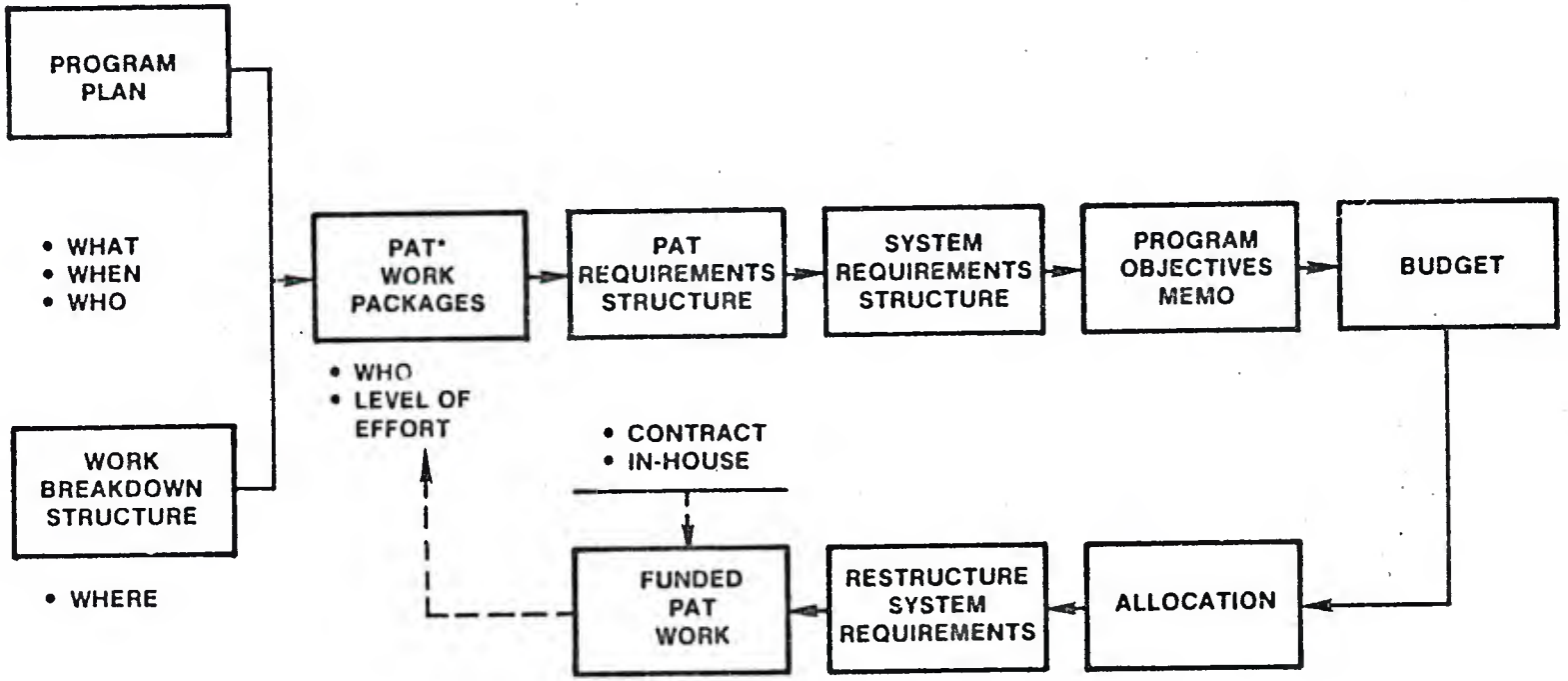
the work activities related to deployed systems is usually applied across the board for all systems and is funded from the O&MA account. The fact that the work is level of effort oriented requires that detailed attention be paid to defining the level of effort and incorporating funding requirements to accomplish the effort into appropriate budget accounts. The process of defining the work is called programming. Budgeting is the process of obtaining approval to obligate funds to do the work. An important point to stress is that programming and budgeting for accomplishing product assurance and test work is integrated with the overall programming and budgeting process for the system acquisition. Since the exercise is not a separate entity, it is important that a systematic approach be taken to defining product assurance and test funding requirements for incorporation into the overall system programming and budgeting process. This means, of course, that the product assurance and test personnel must be involved in the programming and budgeting process.

The programming efforts begin with a definition of the requirements for product assurance and test work. These requirements are defined on a fiscal year basis for each work package. In-house and contractor requirements are defined separately, thus giving visibility to the contractual efforts and the in-house management and support efforts. A product assurance and test program plan and work breakdown structure are essential prerequisites if the estimates of required funding are to be credible. The project manager must know what work will be done, when it will be done, and where it will be done in order to make decisions regarding the structure of his funding

requirements and in defending the need for these requirements. The total requirements become a line entry in the Army's Program Objective Memorandum, which is forwarded to Department of Defense (DOD) for approval. Based on the DOD guidance, the Army budget is prepared and submitted to DOD for approval and transmittal to the Office of Management and Budget. Considering the fact that it currently takes about twenty months from the time a requirement is identified until budget authority is received from Congress, considerable forward planning is required to anticipate a realistic level of funding. Also, since Congress only provides budget authority for one fiscal year at a time, the programming and budgeting process is a continuous cycle. The bottom-line to all this is that programming has a very real impact on program success and that continued involvement in programming product assurance and test requirements is essential.

When budget authority is received by DOD, a process of allocating obligation authority to the various program elements occurs. It is almost inevitable that the project will not get the total amount of obligation authority which was originally requested. This will require a restructuring of the program. All to often, product assurance and test functions are not fully funded simply because the project manager does not have visibility of the structure and need for these requirements. Here again, proper programming of the work can provide the project manager with an insight for making appropriate trade-off decisions within the overall structure of programmed funding requirements. Figure 11 summarizes the programming and budgeting process as it relates to the product assurance and test function.

PROGRAMMING AND BUDGETING PROCESS



*PAT — PRODUCT ASSURANCE AND TEST

Figure 11

SECTION VI

MANAGEMENT CONSIDERATIONS

In this final section of the guide, some considerations are offered on the management functions of planning and controlling as they relate to the product assurance and test function.

Planning

Someone once said that any road will get you there if you don't know where you're going. This thought aptly sums up the importance of planning in any endeavor. The key to successful completion of any job is to set down the end results to be achieved, lay out a strategy to get there, and stick to it. All too often, elaborate plans are drawn up, only to function as a show-case while something else, or nothing, is really being done. An essential feature of any plan is that is must be structured to facilitate accomplishment of the work. Another feature is that plans should provide a basis for an audit-trail for comparing what work was accomplished against what work was planned. This feature is an essential element for control of the work, since it permits the identification of deviations.

The planning activity for the product assurance and test function should be based on the work packages. Detailed plans for each work package should be prepared. These work package plans are used at the organizational level where the work is performed. The detailed plans should be summarized into an overall product assurance and test functional plan. This plan is used

at the first level of management where the function is controlled. The functional plan is summarized for input into the project master plan, or overall System Development Plan for Army programs. The project manager uses this overall plan to assure that the work in the various functional disciplines is being accomplished. This approach to planning results in a hierarchy of plans as shown in Figure 12.

Control

Since the product assurance and test function is based on the philosophy of assurance, it provides the project manager with a mechanism for exercising control. The effectiveness of the function in the control role is enhanced when the product assurance and test functional element is organizationally independent of the functional elements responsible for the technical, cost, and schedule aspects of the program. This independence provides both independent assessment and support roles for the product assurance and test function. The independent assessment role can be used as a "checks and balances" system by the project manager. Such an approach of "checks and balances" is based on credible assessments of the system's status and problem areas throughout the acquisition process. It is emphasized that this technique provides the project manager with a different perspective of problem areas and should be considered as another informational input into the decision-making process. Periodic assessments are occurring throughout the acquisition cycle, as shown in Figure 13. The project manager should ask for a system assessment update prior to each major decision milestone, as a minimum.

PLANNING HIERARCHY

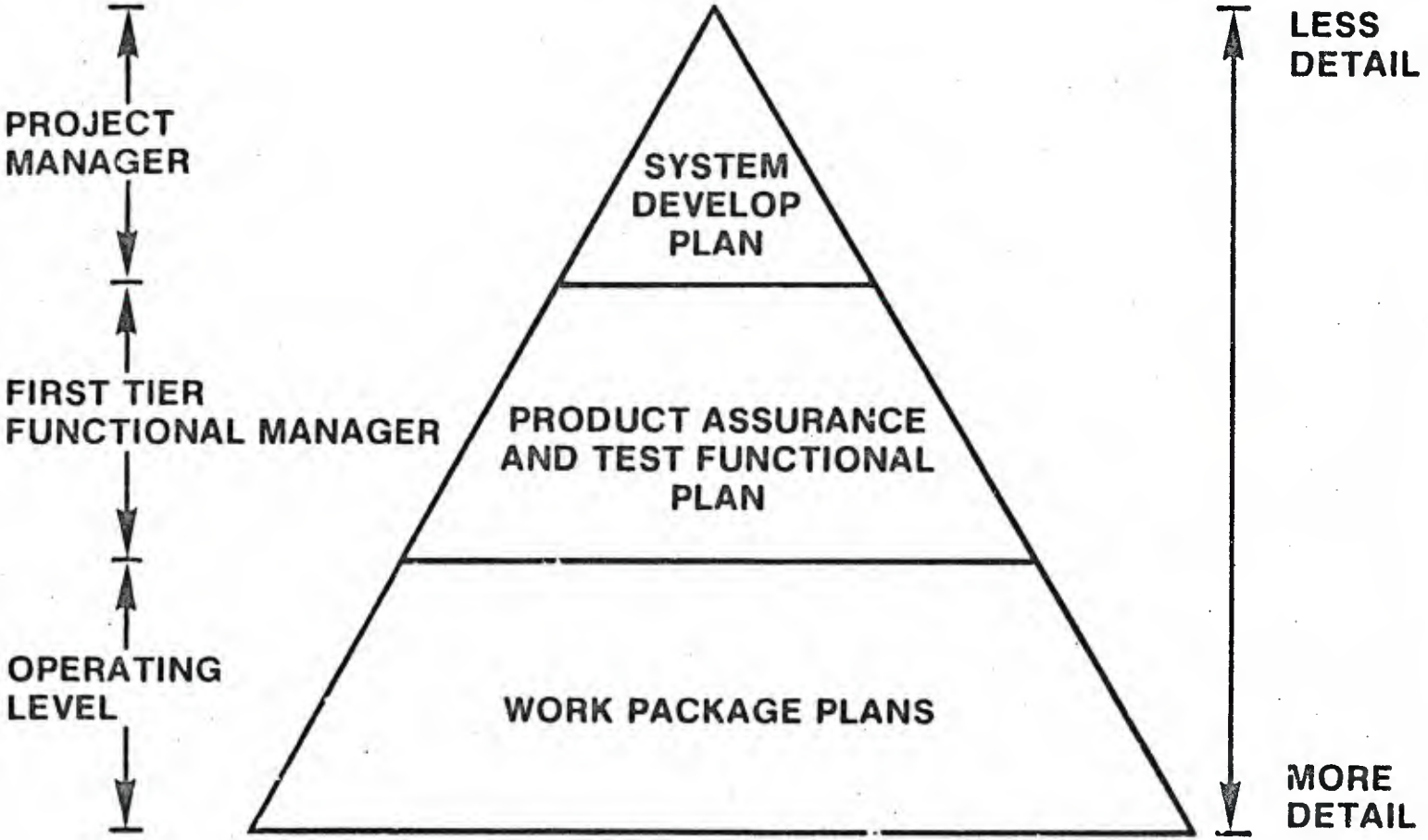


Figure 12

"CHECKS AND BALANCES"

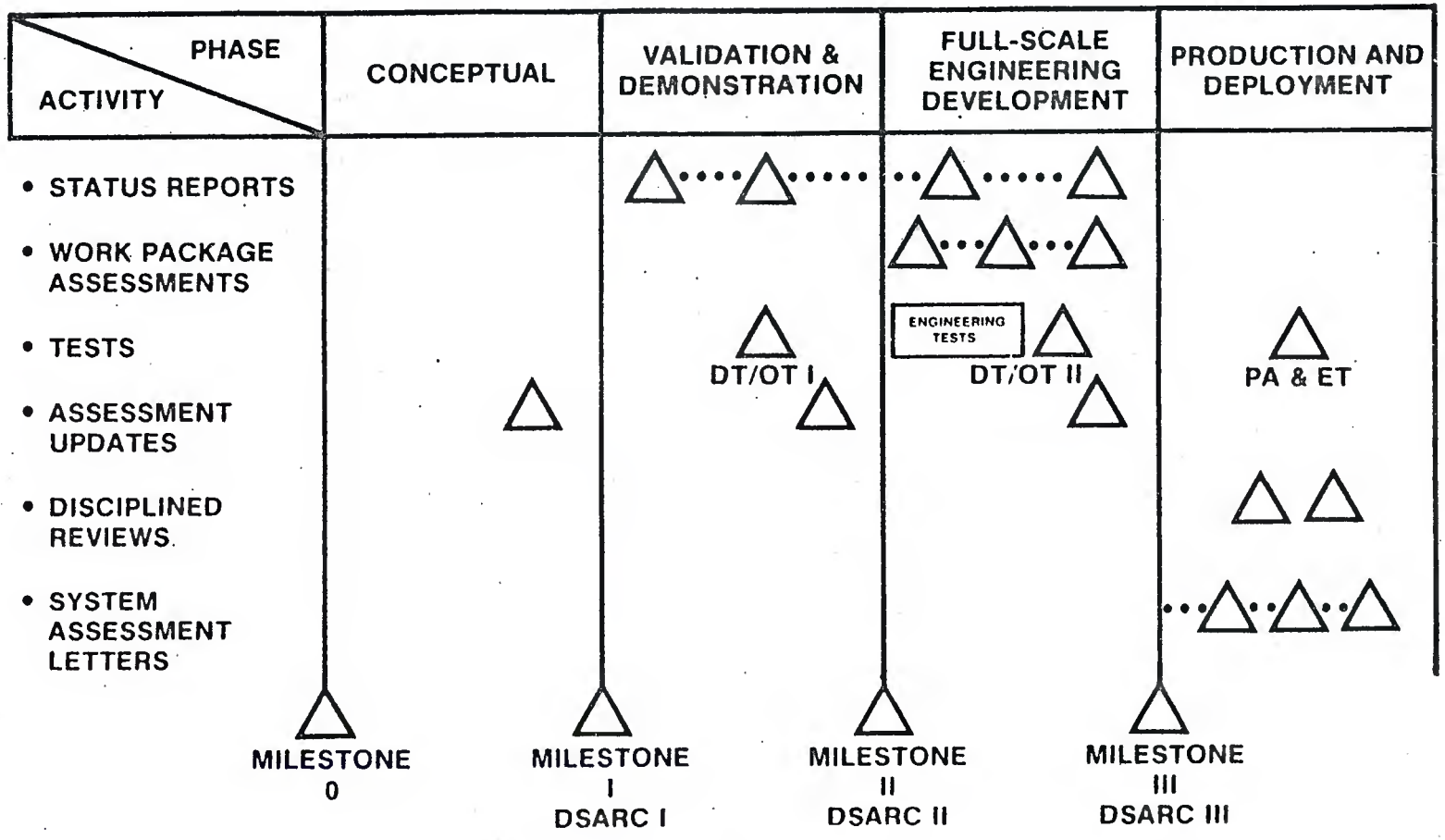


Figure 13

Conclusion

At the beginning of this paper, its purpose was stated as one of developing a basis for understanding, from a management viewpoint, the process of accomplishing product assurance and test functions during Army acquisition programs. I hope this purpose has been accomplished within the scope of this paper. Hopefully, this paper will stimulate new thoughts and ideas on the utilization of product assurance and test in Army acquisition programs.

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